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Governance Strategies and Welfare Effects: Vertical Integration and Contracts in the Catfish Sector in Vietnam

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Abstract

Using an original dataset from the Vietnamese catfish sector, we study the impact of vertical coordination options on household welfare and the implications of different stages of vertical coordination for the success of the whole sector. The welfare gain from contract farming and employment on processor-owned estate farms is estimated using a maximum simulated likelihood estimator. Our results show positive welfare effects from participating in contract farming, but not from employment on processor-owned estate farms. The results imply that contract farming presents opportunities for economic growth, but additional effort is required to make the contracts more accessible to smallholders.

Key words: vertical coordination, catfish, maximum simulated likelihood, agri-food transformation, Vietnam

JEL codes: D02, D31, O17, L14, L24

1. Introduction

Farmers from developing countries are connected to consumers in global markets through a series of arrangements that range from spot market transactions over contracts to full vertical integration of ownership of all transaction stages. The effects of these different arrangements – or modes of vertical coordination – on the participants of the modern agro-food sector are highly debated. While one group of studies points to severe consequences of the exclusion of smallholders from global markets (Reardon, Barrett, Berdegué, & Swinnen, 2009) and raising income inequality with the proliferation of contract farming schemes (Little & Watts, 1994), another group of studies argues that rural areas can benefit from participation in global trade because of (i) positive effects of participation in export on farmers' productivity (Minten, Randrianarison, & Swinnen, 2009), (ii) employment opportunities (Maertens & Swinnen, 2009) and (iii) access to technology, inputs and investment (Gow & Swinnen, 1998). Many of these benefits are, however, available mainly to vertically integrated farms (Dries & Swinnen, 2004).

Taking the case of striped catfish[1] farmers in Vietnam, this paper investigates welfare effects of different vertical coordination options, namely contract farming and full vertical integration of catfish farms by processing companies. Catfish is a farmed freshwater fish that is marketed under several other names: pangasius, swai, basa, river cobbler or iridescent shark. The catfish export chain is a relevant case for a study of vertical coordination outcomes for several reasons. With substantial markets in more than 100 countries worldwide, total production of over 1 million metric tons and an export turnover of more than USD 1 billion, the Vietnamese catfish has become a major global industry over the past decade (Phuong & Oanh, 2010). The increase in export volumes was followed by changes in sector organisation and governance structure. Bosma et al. (2011) report a growing trend for vertical integration of farms by processing companies in the sector. It is not known how these changes affect participants, as the sector has scarcely been studied until recently, when several studies investigated the broader political-economic setting in which the industry has developed (Belton, Little, & Sinh, 2011; Loc, Bush, Sinh, & Khiem, 2010).

1. Termed catfish in the rest of the paper.

In this paper we assess the welfare effects of different vertical coordination options in the catfish sector. In particular, we compare the outcomes from farming catfish as either non-integrated, contract or estate farmer. We aim to answer several questions: Who benefits from vertical coordination in the sector? What is the best governance option for the average farmer? What is the best governance option for the whole sector? Understanding the incentives and outcomes of participation in different institutional arrangements may lead to better arrangements for production of high-value export commodities and improved smallholder welfare in developing countries.

The analysis is based on an original dataset from the Vietnamese catfish sector and qualitative interviews with key actors from the sector. We aim to contribute in three ways to the literature on the consequences of transformation of agri-food sectors, where contract farming and vertical integration are recurrent themes.

First, we simultaneously compare the effect of two vertical coordination forms on farmers' welfare. The impact of contract farming on smallholders' livelihoods has received sizeable attention (see Bellemare, 2012; Miyata, Minot, & Hu, 2009; Warning & Key, 2002), but only Maertens and Swinnen (2009) compare the effect of contract farming and employment on industrial farms with non-participation. They estimate the effects of contract farming and employment, respectively, using propensity score matching, thereby assuming that conditioning on observable variables is sufficient for determining the causal effect of vertical coordination on household welfare. As processing companies may choose employees on the estate farms and contract farmers based on unobservable characteristics, such as effort or managerial abilities, we use an instrumental variable approach. Specifically, we estimate the impact of contract farming and estate employment using the maximum simulated likelihood estimator developed by Deb and Trivedi (2006). Second, unlike studies that compare producers in the export sector with producers that exclusively sell in the domestic market (for example, Maertens & Swinnen, 2009), we estimate the welfare outcomes for three groups of farmers that all participate in the catfish export sector based on the chosen governance structure. Third,

we use a combination of quantitative and qualitative methods to understand and explain individual and contextual drivers of vertical coordination, and to elicit the functional relationship between farmers' welfare and vertical coordination.

Our results show that the gain from participating in intensive export sectors depends on the governance structure. Although belonging to a high-value export sector is not conditioned by contracts, we find that producing under contract has a positive effect on consumption expenditure when evaluated against the situation of non-integrated farmers. Conversely, we find no difference in welfare between estate farm employees and non-integrated farms. Thus, our results imply that traditionally vulnerable groups – such as landless wage labourers who work on estate farms – are not left behind in the process of rapid transformation of rural economies with the arrival of high-value export sectors because they can look for employment on estate farms and thereby achieve the same level of wellbeing as the non-integrated farmers.

2. Overview of the Catfish Sector

Vietnam has been the home of intensive aquaculture production since the 1990s – a period of high investments in production of several exportable species of shrimp and white fish. The catfish sector developed in rural areas of the Mekong River Delta (MRD) from subsistence farms that grew catfish for personal consumption. Catfish was sold in local markets until the early 2000s, when pond cultivation became intensified to accommodate the growing interest in export.

The current catfish farming area is around 6,000 hectares (Dzung, 2011). In 2010, farmers produced 1.35 million metric tons of catfish and exported 660,000 metric tons of frozen catfish fillets bringing the USD 1.43 billion of export revenue (Dzung, 2011). Catfish is currently the second most exported commodity in terms of volume, after rice.

The sector is based on intensively farmed holdings (Phan et al., 2009). Accompanying the development of intensive farms was a growth in the number of hatcheries, nurseries and

processing companies. Processing companies are involved in primary production through contracts or direct farm ownership and management.

The development of the sector has not been without disturbances. Vietnam faced trade disputes with the USA in 2002-2004 over the use of the name catfish, which in the USA remained reserved for the local channel catfish (Cuyvers & Binh, 2008). As a result, the share of catfish exported to USA decreased from 80 to 4 per cent (WWF, 2010). In 2010, catfish appeared on WWF's Red List that advises consumers against buying unsustainable products. Soon after, it fronted negative publicity in European media for being unsafe for consumption due to intensive use of antibiotics in production and negative environmental impact (Bush & Duijf, 2011).

Concurrent with the global financial crisis, demand fluctuations and price volatility caused financial losses to 50 per cent of catfish farmers (Sinh & Hien, 2010). These changes affected small-scale farmers, who switched to producing less capital-intensive aquaculture species or agricultural commodities, leasing their ponds and becoming employed by processing companies. Overall, between 30 and 50 per cent of farmers stopped producing catfish since 2009 when the number of farmers was around 4,000 (SFP, 2011; Vietnamnews, 2011).

All of these events, to which catfish producers and processors needed to adapt, influence the structure of the sector. The loss of the American market called for new product outlets. At first, the surplus went to the EU countries, but with the strict food regulation for imported products, the market absorbed only the highest quality products. The so-called second grade products are sold at a lower price in Eastern Europe, Middle East and Latin America.

3. Study area and data

The analysis is based on the data obtained through qualitative interviews, farmer survey, field observations and published material. The data collection took place from April to June 2011 in three provinces in the MRD: Can Tho, Dong Thap and An Giang that

produce 70 per cent of total catfish output in Vietnam (VASEP, 2012). Qualitative interviews included 52 interviewees with specialised knowledge about the sector (see the Appendix).

The targeted population for the survey was that of operators on catfish farms. The survey comprised 276 catfish farmers. Data collection relied on the assistance of the commune staff and the employees in the local offices of the Ministry of Agriculture and Rural Development who would lead enumerators to the survey location. The average non-response rate is estimated to be around 25 per cent at the end of the survey.

The questions in the questionnaire referred to respondents' situation in 2010. Apart from basic household and demographic information, the survey data contains information on asset ownership, marketing choices, infrastructure, expenditure and consumption. The consumption expenditure module was aligned to the Vietnam Household Living Standard Survey (GSO, 2011), which is a Living Standard Measurement Surveys questionnaire type used for assessing poverty and wellbeing in Vietnam.

4. Analytical Framework

4.1. Theoretical Background

A multitude of institutional arrangements can be found in modern value chains, where incentives of firms to vertically integrate primary production, to contract out or to rely on spot markets arise as a response to market imperfections (Williamson, 1975). Vertical coordination is an umbrella term used for describing institutional arrangements occupying a range between spot market exchange and full ownership management. Various forms of coordination exist between these two extremes, but production contracts are the most relevant in the agri-food sector in developing countries (Reardon et al., 2009). Marketing contracts and resource providing contracts are the two most common types. *Marketing contracts* are agreements between a contractor and a supplier that specify some form of a price and outlet *ex ante*, while *resource providing contracts* (also called *outgrower*) include farm assistance, such as extension and management services, inputs or credit supplied by the contractor (Swinnen & Maertens, 2007). While spot

markets assume coordination of activities in the value chain through price, full vertical integration assumes ownership of adjacent stages of a value chain into one firm. Especially in the case of developing countries in recent years, there has been a move from spot market transactions toward increasing vertical coordination, where the level of coordination differs between different stages in the value chains (Gereffi, Humphrey, & Sturgeon, 2005). These trends towards higher degree of coordination are induced by market failures such as asymmetric information, failures in markets for credit, insurance, inputs or services (Key & Runsten, 1999).

Recent research has investigated how various market imperfections and transaction costs determine organisational structure in a particular sector. After controlling for household characteristics, it was found that farmers who participate in the export sector under different institutional arrangements (contracts or employment) enjoy positive income effects of participation (Bolwig, Gibbon, & Jones, 2009; Minten et al., 2009; Rao & Qaim, 2011). Thus, in addition to increasing farmers' welfare, vertical coordination arrangements may also carry over positive spill-over effects to the local economy in terms of employment, infrastructure and market development. An adjacent line of research has focused on farm characteristics that favour vertical coordination. In particular, farmers selling to supermarkets dispose higher land and capital endowments, and their production is more specialised (Neven, Odera, Reardon, & Wang, 2009). Whereas firm's choice of governance structure (vertical integration, contract or spot market) depends on terms and conditions it is able to negotiate with farmers, these conditions also determine characteristics of farmers who accept the contract[2] (Key & Runsten, 1999).

4.2. Estimation Strategy

We wish to estimate the (causal) impact of vertical coordination, I_i, on household welfare, Y_i, recognising that the vertical coordination outcome is not independent of household's socio-economic status and other characteristics. We start by identifying farmer characteristics that result in different vertical coordination options. The observed

2. More details are available in the Appendix.

alternatives are non-integration (j = 0), vertical integration, that is, estate farming (j = 1) and contract farming (j = 2). Non-integrated farmers sell on the spot market. Estate farmers are employees on processor-owned farms, which are considered fully vertically integrated as a company's share in ownership exceeds 50 per cent. Estate farms initially emerged as a processors' response to weak quality assurance capabilities of farmers, but after the crisis in 2009, the key incentive for the integration became reducing uncertainty through stable fish supply. Contract farmers have either outgrower or marketing contracts with some of the processing companies. The outgrower contracts imply that a processing company supplies inputs (such as fry, fingerlings, feed and medicines) to the farmer, while the farmer delivers specified quantity of the fish of exportable quality. The production process follows the prescribed hygiene rules and ensures low mortality rates of fry and fingerlings. Marketing contract only stipulates quantities and price, with the price being conditioned on the quality test performed right before the purchase. This contract type is found in 83 per cent of contract farms in our sample. The weak contract enforcement makes the ties between processors and farmers much more flexible in case of marketing contracts than in the case of outgrower schemes.

Table A1 in the Appendix gives the basic descriptive statistics of our sample that comprises 85 estate, 88 contract and 103 non-integrated farmers. These farm categories are mutually exclusive, that is, a farmer can belong to only one of three groups, because the decision to contract with a processing company or to work on estate farms reflects a commitment that is not partial. Unlike in high-value export sectors in other countries where farmers allocate only part of their land and labour to export activities while continuing to be independent smallholders (see Maertens & Swinnen, 2009), the catfish farmers dedicate all of the production area to contract farming or become full-time employees on estate farms.

The selection of the vertical coordination form and the resulting outcomes for the farmers are driven by transaction costs, perceptions of the alternatives and, in the context of weak contract-enforcing environment, by trustworthiness, reliability or reputation. These are typically unobserved by the researcher, while processors are more likely to possess such

information, or some specific indicator of it. To achieve an unbiased estimate, we use the maximum simulated likelihood (MSL) estimator proposed by Deb and Trivedi (2006).

We compare the outcome for contract and estate farms with the outcome for non-integrated farmers, which we believe, constitute a good comparison group. As almost total catfish production is exported, all three groups of farmers sell in the same marketing channel but under different conditions. In this way, we obviate the problem of confounding the effect of vertical coordination with the effect of participation in two different marketing channels: selling in domestic market or for export.

We estimate the following model:

$$Y_i = \boldsymbol{\beta x}_i + \rho_1 I_{i1} + \rho_2 I_{i2} + \lambda_0 t_{i0} + \lambda_1 t_{i1} + \lambda_2 t_{i2} + \varepsilon_i, \quad (1)$$

where Y_i is the per capita consumption expenditure for household i in the year 2010, $\boldsymbol{x_i}$ are the observed farm characteristics and the coefficients ρ_1 and ρ_2 are the average effects of vertical coordination on per capita consumption. As the decision about vertical coordination is made with future welfare in mind, the decision to integrate is not exogenous. Assuming I_1 and I_2 are exogenous would result in inconsistent estimates of ρ_1 and ρ_2. In equation (1), we denote the unobserved characteristics that influence both the coordination decision and welfare as t_{ij} and coefficients associated with unobservable characteristics as λ_j . Thus, conditional on both the observables in $\boldsymbol{x}_i$ and the unobservables in t_{ij}, the estimated partial effect of integration can be considered as the causal effect. The independently distributed random error is denoted as ε_i.

We use the consumption expenditure as the dependent variable because it is 'a more useful and accurate measure of living standards than … income' (Deaton and Grosh, (2000, p. 94). Consumption expresses the welfare in terms of resources and prices; it reflects the longer-term living standard, surpassing the problem of seasonal changes in income or poverty status and respondents may be more reluctant to truthfully share

information on income (Chen & Ravallion, 2010; Deaton & Grosh, 2000). Consumption expenditure is also preferred because the welfare effect measured in terms of income may be imprecise as different types of costs are faced by three groups of farmers, especially in terms of loan interest rates and investment. For example, processing companies are the ones investing in estate farms, not the farmers who work on these farms. Comparing the income levels would in this setup overestimate the welfare effect of estate farming.

We use the yearly per capita consumption expenditure created from recall information about respondents' daily expenditures on food, drinking and smoking, monthly expenses for water, electricity and telephone and yearly expenditure on clothing, education, healthcare, transport, house rent, transfer payments and festivities. The questionnaire contained enough space for naming other relevant expenses in case that the list of specific items was not comprehensive enough. All expenses apart from production inputs were added so they can represent an indicator of the living standard over the year (Ravallion & Chen, 2005). Further, per capita consumption expenditure was calculated using the OECD adult equivalence scales (OECD, 2009).

The controls, $\boldsymbol{x_i}$ include a range of household and farm characteristics, as well as the variables for proximity to markets and services, which are described in Table A1 in the Appendix. Individual farmer and household characteristics (for example age, education, household size and composition) and ownership of assets (production and household assets) may affect the probability of vertical coordination. In the context of this study, it is expected that younger and better-educated farmers have greater chances of benefiting from contracts and employment on the estate farms, as found in previous studies (Barrett et al., 2012). While the experience with fish farming may be important for contracts, it is not crucial for the employment on the estate farms where processors look for specialised skills and higher education. Household characteristics, such as household size and composition are important determinants of the effects of vertical coordination. They measure the household labour endowment so the expected relationship with consumption is positive. The relationship can, however, be negative depending on the structure of expenditures (Deaton & Grosh, 1998).

Farm resource endowments are potentially positively related with consumption expenditure and vertical coordination. Larger farms are probably more attractive to processors as they enable benefiting from economies of scale (Maertens and Swinnen, 2009). We control for the effects of household endowments through an asset index, which represents a stable measure of household welfare (Carter & Barrett, 2006). Farmers must have access to information about best farming practices, which they are likely to obtain from other farmers during local community meetings. Therefore, the expected relationship between consumption and attendance of community meetings is positive. Renting land for catfish production deters vertical coordination. As religious groups may be inclined to collaborate more closely (Bandiera & Rasul, 2006), we expect to find a positive relationship.

Processors may prefer to contract or establish farms in convenient locations, so we consider the possibility of a location bias. Thus, we look at the prevalence of vertical coordination at the village level where 23 per cent of the villages have only non-integrated farms; 26 per cent of the villages have at least one contract farm; 36 per cent of the villages have at least one estate farm and 15 per cent of the villages have both contract and estate farms. The location of farms with respect to the buyer may be decisive for vertical coordination as it is assumed that processors would prefer working with farms positioned closer to the processing facilities. To control for the influence of location, we use three variables: distance between the farm and the buyer, distance to the nearest health centre and average farmgate price at the village level. These variables enter the model exogenously as they primarily capture the potential exposure to information about different vertical coordination options. While living in a specific location may determine farmer's exposure to the information about vertical coordination, it may not affect how much the farmer will profit from it. We expect to find a negative relationship between consumption and distances from buyers and health centres, which would indicate overall remoteness from major markets, services and sources of information. We expect to find a positive relationship between the average price of catfish in the village and consumption

as higher prices would positively translate into higher revenue and income available for consumption.

The estimation of the impact of vertical coordination on household welfare proceeds as in Deb and Trivedi (2006). When $\rho_1 > 0$, farms owned by processing companies (estate farms) have higher per capita consumption than non-integrated farms, on average, and when $\rho_2 > 0$, contract farms have higher per capita consumption than non-integrated farms, again on average. Apart from enabling us to compare effects of two forms of vertical coordination, the joint model allows direct interpretation of selection effects through factor loadings λ_1 and λ_2. If $\lambda_2 > 0$, the unobserved characteristics that induce a farmer to participate in contract farming are associated with a higher consumption. Because better-skilled farmers are expected to opt for contract farming, $\lambda_2 > 0$ is interpreted as evidence of favourable selection. Adverse selection is present if $\lambda_2 < 0$. Analogous interpretations apply to λ_1 with respect to estate farms.

In previous research, participation in contract farming has been instrumented using a randomly assigned hypothetical measure of farmers' willingness to pay for participation in contract farming (Bellemare, 2012), membership in a farmer group (Rao & Qaim, 2011), distance between respondent's farm and the farm of the village leader (Miyata et al., 2009), transaction costs related to the purchase of inputs (Roy & Thorat, 2008) and measures of respondent's trustworthiness (Warning & Key, 2002). We take a different route and use two instrumental variables that capture network and information effects to remedy endogeneity problems in the estimation.

The choice of instruments is based on the observation about the strong influence of social collateral and information on vertical coordination outcomes (Reardon et al., 2009). By this, we assume that the costs of search, selection, information, procurement and investment decrease with the proximity and the knowledge about primary production. We use two village-level indicator variables as instruments, because the occurrence of vertical coordination in a certain area might imply lower transaction costs for processors. Expecting to observe a positive relationship between the history of contracts in a certain

village and subsequent occurrence of contracts, the first instrument is the number of years since the first contract in the village. In similar vein, the second instrument is the share of estate farms in a specific village, assuming that processors will have lower cost of establishing links with farmers in familiar localities. Both of our instruments help to partial out the bias caused by individual predispositions. Using the prevalence of different forms of vertical coordination in a particular area in previous years that can be considered exogenous with respect to individual-specific unobservable factors and household welfare enables us to decrease the endogeneity bias.

5. Results

5.1. Determinants of Vertical Coordination

In this section, we analyse which variables can inform on vertical coordination status of a farm. As Table 1 shows, the vertical coordination depends on several indicators of human, social and physical capital of catfish farmers. Columns (1) and (2) show results from the multinomial logistic regression; columns (3) and (4) show the first stage results from the 2SLS estimation with instrumental variables and columns (5) and (6) show the equivalent for the MSL model. The results of three models are fairly consistent in terms of the sign and significance of control variables.

Column (3) in Table 1 shows a positive relationship between the aquaculture area size and the likelihood to be estate farmer. A positive relationship is also found for the multinomial logit estimation in column (1) and the MSL estimation in column (5), but the magnitude is not statistically significant. Estate farming is more likely for younger farmers with smaller households, whereby processors prefer investing in larger farms where they employ workers who still have not started their families. Possibly the inability of farmers to farm on their own – seen as the inability to secure sufficient amount of capital and support through a business network – leaves them with no other choice but to become employed by a processing company. This was corroborated in our qualitative interviews where several interviewees mentioned that they would gladly establish their own farm were it currently affordable. Just as contract farming, estate farming is more likely if the household head attends community meetings.

The probability to produce under contract increases if the household head has completed any form of secondary education. Experience with catfish production negatively affects the probability of contract farming, implying that processing companies possibly look for specific skills rather than experience in choosing contract farms. Contracts are more likely for farmers who attend community meetings and who are not religious. Farmers who observe higher village-level prices of catfish are more induced to contract.

The instruments significantly predict the vertical coordination outcomes. The statistical significance of the first instrument – the share of estate farms in a specific village – is high for the estate farm outcome and the sign is consistent with our expectations: higher prevalence of estate farms in a specific village increases the likelihood of finding employment on estate farms. At the same time, higher incidence of estate farms decreases the likelihood of contract farming, shown in columns (2) and (4). The presence of estate farms for contract outcome is not significant in the MSL estimation in column (6). The second instrument – number of years since the first contract has been signed in the village – is statistically significant. The direction of influence is positive for both contract and estate farms. This finding means that the early adoption of contract farming in a specific village will increase the probability of contracting more farmers in the future, and it will also increase the probability of establishing estate farms. The F-statistic for a test of joint significance of the two used instruments is 21.74, precluding weak instrument concerns (Stock & Yogo, 2005)[3].

3. At 21.74, the F value is higher than critical values proposed by Stock and Yogo (2005). Stock-Yogo weak identification test critical values: 10% maximal IV size 7.03; 15% maximal IV size 4.58; 20% maximal IV size 3.95 and 25% maximal IV size 3.63.

Table 1. Determinants of vertical coordination

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Estate	Contract	Estate	Contract	Estate	Contract
Estimator	Multinomial logit		2SLS first stage		MSL[a] first stage	
Aquaculture area size (log)	0.088	-0.019	0.037*	-0.015	0.532	0.040
	(0.080)	(0.033)	(0.021)	(0.019)	(0.454)	(0.233)
Household size (log)	-0.314**	0.137	-0.092**	0.066	-1.771**	0.347
	(0.137)	(0.102)	(0.040)	(0.057)	(0.737)	(0.618)
Age of the household head	-0.010*	0.008*	-0.004**	0.004	-0.046*	0.033
	(0.005)	(0.004)	(0.002)	(0.003)	(0.028)	(0.027)
Secondary education	-0.068	0.166**	-0.010	0.123**	-0.073	0.977**
	(0.148)	(0.083)	(0.045)	(0.049)	(0.850)	(0.394)
Share of children 15 and under	-0.030	0.270	-0.057	0.191	0.858	2.229
	(0.285)	(0.181)	(0.110)	(0.124)	(1.863)	(1.368)
Household labour	0.032*	-0.042	0.017**	-0.015*	0.111	-0.178
	(0.019)	(0.027)	(0.008)	(0.008)	(0.080)	(0.177)
Asset index	0.057	-0.009	0.015	-0.007	0.285	0.056
	(0.103)	(0.041)	(0.029)	(0.024)	(0.589)	(0.249)
Experience with catfish	-0.017	-0.012	-0.004	-0.011**	-0.124	-0.107**
	(0.015)	(0.009)	(0.003)	(0.005)	(0.082)	(0.052)
Community meetings	0.028	0.019	0.012*	0.012	0.236**	0.196**
	(0.023)	(0.014)	(0.007)	(0.008)	(0.107)	(0.080)
Religious	0.132	-0.171**	0.038	-0.073	0.493	-0.886**
	(0.117)	(0.078)	(0.037)	(0.047)	(0.766)	(0.450)
Renting land	0.053	-0.152*	0.004	-0.069	-0.010	-1.054
	(0.149)	(0.085)	(0.052)	(0.061)	(0.979)	(0.865)
Distance to buyer (log)	0.024	-0.010	0.004	-0.013	0.140	0.010
	(0.036)	(0.022)	(0.011)	(0.016)	(0.197)	(0.134)
Distance to nearest health centre (log)	-0.059	0.045	-0.024	0.027	-0.268	0.197
	(0.047)	(0.030)	(0.017)	(0.020)	(0.252)	(0.161)
Average village-level price	1.38e-06	8.33e-06	4.29e-07	4.94e-06	0.00002	0.00006*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Share of estate farms in a village	0.015***	-0.004***	0.009***	-0.002***	0.088***	0.001
	(0.002)	(0.001)	(0.000)	(0.001)	(0.011)	(0.010)
Years since the first contract in the village	0.001	0.038***	0.005**	0.030***	0.092*	0.270***
	(0.009)	(0.009)	(0.002)	(0.006)	(0.054)	(0.054)
Constant			0.270***	-0.030	-1.037	-4.323**
			(0.100)	(0.139)	(1.544)	(1.701)
N	270	270	269	269	269	269
Pseudo R^2	0.549	0.549	0.717	0.367		
Kleibergen-Paap Wald F statistic			21.74	21.74		

Notes: Columns (1) and (2) show marginal effects. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. Robust standard errors clustered at village level are in parentheses. Estimation results are probability-weighted.

[a] MSL stands for maximum simulated likelihood treatment regression.

5.2. Welfare Effects of Different Vertical Coordination Forms

Panel (a) in Table 2 shows that consumption expenditure depends on the farm type. The relationship is seen applying the OLS, 2SLS and treatment MSL estimation. Using different estimators, we show a positive impact of contract farming on household welfare. The OLS regression shows that securing a contract with a processing company can potentially increase household welfare by 27 per cent. Controlling for the unobserved heterogeneity with 2SLS and MSL estimators, we obtain about four and three times higher impacts, respectively. The effect of contract farming in the 2SLS regression in column (2) is the highest at 112 per cent, surpassing the 90 per cent gain obtained in the MSL estimation. In contrast, the effect of estate farming is not significant even at the 10 per cent level of significance in any specification.

In Table 2 we observe that farm size, age of the household head, labour endowments and asset ownership positively affect consumption expenditure. Likewise, being able to rent land secures higher welfare. Average village-level prices for catfish are positively correlated with consumption, but the size of the coefficient is too small to bear any economic significance. Also, we observe a negative association between larger households and welfare.

The lower section of Table 2 shows the MSL estimates of the unobserved heterogeneity bias. Selection on unobservable characteristics appears to be important for both estate and contract farms. The sign of the latent factor λ_1 is positive and statistically different from zero, indicating a positive selection into estate farming based on the unobservable characteristics relative to that of a random farmer. The sign of the latent factor λ_2 is negative and significant at one per cent significance level, suggesting that unobserved characteristics, which increase the probability of belonging to contract farming group also lead to lower household welfare. This may imply that contracts are appealing to somewhat poorer households with worse relationships with the industry. Conversely, the wealthier households may not need contracts as they can potentially rely on personal connections (unobservable) to secure sales. This explanation seems plausible as the importance of personal ties when choosing suppliers was emphasised in the qualitative

interviews with industry representatives. Underscoring this observation, a recent study (Belton et al., 2011) points out the importance of social and political capital in the catfish sector in Vietnam. Describing the labour market in MRD, Akram-Lodhi et al. (2007, p. 168) state that ‘labour is typically hired from family and social networks, in order to ease transaction costs’.

Table 2. The effect of vertical coordination on household welfare. Dependent variable is per capita consumption expenditure (log).

	(a) Full sample			(b) Reduced sample[a]		
	(1) OLS	(2) 2SLS	(3) MSL[b]	(4) OLS	(5) 2SLS	(6) MSL[b]
Estate farm	-0.003	-0.041	-0.023	0.038	0.038	0.010
	(0.189)	(0.277)	(0.192)	(0.218)	(0.265)	(0.231)
Contract farm	0.240*	0.753**	0.640***	0.255*	0.705**	0.500***
	(0.144)	(0.366)	(0.176)	(0.150)	(0.346)	(0.166)
Aquaculture area size	0.186***	0.228***	0.214***	0.167**	0.202***	0.188***
(log)	(0.062)	(0.062)	(0.058)	(0.074)	(0.070)	(0.071)
Household size (log)	-0.490***	-0.536***	-0.512***	-0.565***	-0.613***	-0.601***
	(0.155)	(0.149)	(0.146)	(0.157)	(0.151)	(0.155)
Age of the household	0.016***	0.012**	0.013***	0.019***	0.016***	0.017***
head	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)
Secondary education	0.141	0.064	0.071	0.135	0.077	0.107
	(0.138)	(0.143)	(0.131)	(0.161)	(0.162)	(0.154)
Share of children 15 and	0.570*	0.411	0.452	0.704*	0.595*	0.651*
under	(0.331)	(0.305)	(0.311)	(0.370)	(0.360)	(0.359)
Household labour	0.050*	0.055**	0.053**	0.055	0.063	0.062
	(0.025)	(0.024)	(0.023)	(0.045)	(0.041)	(0.043)
Asset index	0.257***	0.250***	0.257***	0.238***	0.228***	0.231***
	(0.067)	(0.063)	(0.063)	(0.075)	(0.075)	(0.073)
Experience with catfish	0.011	0.012	0.012	0.022	0.020	0.020
	(0.011)	(0.012)	(0.011)	(0.019)	(0.018)	(0.018)
Community meetings	-0.033**	-0.039**	-0.037**	-0.035**	-0.040**	-0.037**
	(0.016)	(0.017)	(0.016)	(0.017)	(0.018)	(0.017)
Religious	0.143	0.153	0.140	0.108	0.116	0.107
	(0.145)	(0.136)	(0.137)	(0.155)	(0.145)	(0.148)
Renting land	0.634***	0.727***	0.705***	0.556***	0.650***	0.606***
	(0.201)	(0.195)	(0.200)	(0.156)	(0.169)	(0.161)
Distance to buyer (log)	-0.063	-0.055	-0.052	-0.068*	-0.062	-0.064
	(0.041)	(0.042)	(0.040)	(0.040)	(0.041)	(0.040)
Distance to nearest	-0.037	-0.063	-0.058	0.007	-0.015	-0.007
health centre (log)	(0.054)	(0.055)	(0.054)	(0.067)	(0.068)	(0.066)
Average village-level	0.00002**	0.00002**	0.00002**	0.00002***	0.00002***	0.00002***
price	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	14.34***	14.48***	14.44***	14.08***	14.22***	14.19***
	(0.387)	(0.377)	(0.358)	(0.461)	(0.451)	(0.452)
N	269	269	269	217	217	217
R^2	0.343	0.306		0.350	0.320	
F	9.56	9.60		10.510	9.202	
λ_1 (estate farms)			0.237**			0.211
			(0.113)			(0.279)
λ_2 (contract farms)			-0.597***			-0.394***
			(0.140)			(0.110)

Notes: Per capita expenditure level is calculated using OECD adult equivalence scales. Robust standard errors clustered at village level are in parentheses. Estimation results are probability-weighted. Significance levels: * p<0.10, ** p<0.05, *** p<0.01.

[a] The reduced sample is created by restricting the number of observations only to observations in the common support range.

[b] MSL stands for maximum simulated likelihood treatment regression.

There may be a concern that the identified farm categories are not comparable, violating the common support assumption. In other words, composition effects and heterogeneous characteristics of the three groups may influence some of our findings. Contract farms have the highest spread of expenditure (Figure 1 in the Appendix), so it may be that our result, which measures the mean impact, is driven by a few observations with extreme expenditure levels and that these farmers do not have their counterparts in other two groups of farmers. To avert this concern, we calculate propensity scores (PS) – a conditional probability of receiving the treatment (Imbens & Wooldridge, 2009), based on the observed farmer characteristics. First, we compare non-integrated and contract farmers in the nearest neighbour matching estimation and then compare non-integrated and estate farmers using the same method. Based on the first PS estimation, we find that 10 farmers do not have counterparts in the comparison group (96% fall in the common support range) and in the second estimation we find the same for 44 farmers (84% in the common support). Thus, based on observable characteristics, 9 non-integrated farms would never be classified as contract farms and 37 could never be classified as estate farms.

In panel (b) of Table 2 we show that restricting the sample to observations within the common support range yields similar results about the impact of vertical coordination on farmers' welfare. Compared to the full sample, the magnitude of the effect is similar in the OLS and 2SLS estimations (columns (4) and (5)), while the magnitude in the MSL estimation is 25 percentage points lower (column (6)). All estimators on the reduced sample show significantly positive impact of contract farming on welfare. The size of the effect is slightly smaller than for the whole sample, implying that contracts lead to 65 to 102 per cent higher levels of consumption expenditure for participants. Our combined results, thus, point to large gains from contract farming.

A significant positive impact of contract farming on consumption from our study is comparable to the impact of 50 per cent in Bellemare (2012), 32 per cent in Warning and Key (2002) and 39 per cent in Miyata et al. (2009). Our result is different from the study on vertical coordination in Senegal (Maertens and Swinnen, 2009), which shows that

both contract farming and employment on industrial farms increase household welfare. Although we do not find significant welfare gains for employees on estate farms, we side with Maertens and Swinnen (2009) in concluding that contract farms have higher welfare levels than both non-integrated and estate farmers.

Finding no difference in welfare between employees on estate farms and non-integrated farmers is also an important result. Our study shows that the emergence of intensive export sectors is not biased against landless workers who cannot afford to establish their own production. Bearing in mind that the estate farm employees are not landowners, observing that their livelihoods are not different from non-integrated farmers could mean that non-integrated farmers are the most vulnerable group in the sector.

6. Conclusion

Much has changed in Vietnam during the previous decade with the emergence of aquaculture export sectors in which various forms of vertical coordination are replacing spot market transactions. The development of the catfish sector has led to important changes in rural parts of MRD in terms of increased employment opportunities and improved livelihoods. Our results show a significant welfare impact of contract farming after controlling for both observable and unobservable farmer characteristics, while the welfare impact of employment on estate farms is not significant.

Even though there are indications that contract farmers capture most of the gain, our result implies that vertical coordination does not preclude traditionally vulnerable farmer groups from participating in high-value export industries through employment. Since the employees on estate farms are not landowners, it is important to see that their livelihoods are not significantly different from non-integrated farmers. This result, thus, indicates that non-integrated farmers are possibly the most vulnerable participants of the catfish sector.

High transaction costs and information asymmetry, when coupled with a weak contract-enforcing environment, which is prominent in developing countries, give rise to vertical coordination of primary production and processing, and our sample has almost identical

shares of contract and estate farms. However, the main type of contract employed is a marketing contract, which does not include transferring production or management skills from processors to farmers. Some effort should thus be invested in developing contract schemes that convey longer-term technology transfer opportunities.

Given that this study shows higher consumption expenditure, on average, for contract farmers, it follows that rural development initiatives could focus on expanding the activities of processing companies in terms of higher enrolment of farmers for contracting. To enable this, the crucial policy activity in the sector should be directed to creating an environment conducive to participation of non-integrated farmers in contract farming. Increased numbers of contract farmers in the Vietnamese context could be translated into rural poverty reduction. Caution with contract farming schemes should, however, be exercised, as much effort needs to go into the design of contracts that are equitable and inclusive of smallholders who would not be selected for contracting without a third-party intervention.

There are a few remarks about the results. First, contract farmers in this study are identified as having either marketing or production contracts, which could decrease the precision of the result and complicate the comparison of the result with other studies that mostly analyse outgrower contracts. Second, the dependent variable used in the estimation is consumption expenditure, which is not an ideal measure of farm household welfare (Foster & Rosenzweig, 1995). Ideally, farm profits should have been used had the dataset allowed. Third, the cross-section nature of the data has not allowed assessing the welfare effects over time, so that the unobservable characteristics and endogeneity could be controlled for in a more efficient and consistent manner. However, we hope that this study can serve as a point of departure for further work, especially in comparing the vertical coordination outcomes in the catfish sector with other aquaculture and agriculture sectors.

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Appendix

1. Sample and Data

Interviews were held with seven catfish farmers, both household-owned and company-owned; 14 processing companies; five international traders experienced with catfish export; eight government officials comprising employees at the local offices of the Ministry of Agriculture and Rural Development and commune staff engaged in extension services; five input suppliers (feed and veterinary inputs); five local researchers actively engaged in aquaculture research both from production and technology and socio-economic side and eight service providers including NGO representatives, consultants, certification auditors, legal advisors, transport providers and banks. Among the interviewed processing companies, the average output was 21,000 tons/year, ranging between 5,000 and 50,000 tons/year. Five of the interviewed companies are among the top 20 Vietnamese catfish exporters.

Qualitative interviews took a semi-structured form with open-ended questions, lasting 30 to 90 minutes. On some occasion, informal interview format or electronic email exchange were used to collect data, as this was more suitable for the respondents. The interviewees were asked to provide information about a broader regulatory and institutional environment of catfish production, processing and trade. Financial and resource flows were also investigated, as well as the ownership structure of farms and processing companies. The interviews also addressed the motivation of processing companies to contract farmers or to integrate primary production. For interviewees who were able to speak English, the interviews were conducted in English or with the help of an interpreter for Vietnamese in case of non-English speakers. Data obtained through qualitative interviews was verified against published sources whenever possible.

2. Theoretical Background – Details

In our setting, we follow the outcome of a processing company's decision about whether to 'make or buy', meaning whether to integrate backwards into primary production or to

contract[4], which is to outsource primary production. Subsequently we assess the impact of these two vertical coordination options on farmers' welfare. The decision about vertical coordination is made in light of the costs related to these two institutional arrangements: the higher the costs related to contracting primary production, the greater is the incentive for a processor to internalise production. We believe that a processing company's preferred choice in the catfish sector is to organise own primary production. This assertion is based on information from several in-depth interviews with processing companies[5]. Also, only 17 per cent of farmers under contract stated that they receive inputs from the company. This low prevalence of the outgrower contract type tells that if companies want to get engaged in primary production, they would prefer to do it on their own, rather than to support farmers' production. This decision is to a large extent supported by high production risks, such as the occurrence of fish diseases, lower quality, limited application of food standards and consequently, unreliable supply. Being less risk averse, processing companies are reluctant to incur costs of avoiding uncertainty.

As an alternative to owning primary production, a processing company can choose to enter into contractual relationship with selected farmers after which it sets the contract conditions. Being more flexible under market uncertainty, contracts enable the processing companies to entirely transfer production risks to farmers (Grosh, 1994; Singh, 2002). The choice for or against contracting is made in the light of information about the profitability: contracts are offered to the farmers whose profitability seems highest. Further on, the company needs to identify which farmers are likely to be the most profitable suppliers, given the level of uncertainty surrounding farmers' preferences or ability to adhere to the contract (Barrett et al., 2012).

[4] Our sample shows that a dominant form of contracts signed between processors and farmers are marketing contracts whose specifications refer only to the sale conditions. This is possibly due to the weak contract-enforcing environment, which precludes longer-term commitments. As one contract type highly dominates the other, analysing the differential effects of two contract types is not possible in this study.

[5] Several processing companies stated that they are planning to increase sourcing from own production to 100% in the next two to five years. The probable reason for the primary production not being fully integrated at present is that the processors are credit rationed. This is contrary to previous findings (Singh 2002), which – based on the gains from risk reduction for processors – argue for the benefits of contract over fully integrated farming.

By contracting, a processing company aims to secure a desired quantity of unprocessed fish while minimising production costs and transaction costs. While there are several kinds of fixed transaction costs, such as screening, monitoring and extension activities, there are also transaction costs that are proportional to the size of production, such as transport to the processing facilities. It is the proportional transaction costs that drive processors to contract with larger farmers; as most of these costs are incurred on a per-farmer basis, a processor will minimise the transaction costs it faces by contracting with as few farmers as possible. Also, under a binding limited liability constraint, companies would prefer to contract with wealthier farmers.

A farmer will accept a company's contract offer if his perception about the expected welfare from contracting is at least as high as that of not contracting. Contracts can be appealing to farmers as they can offer insurance against market and production risks, provide access to credit, necessary inputs and information about the uncertainties related to production and marketing of high-value commodities (Barrett et al., 2012). We extend the rationale to the selection of estate farming for livelihood. Risk aversion is positively correlated with contract farming (Key & Runsten, 1999) and negatively correlated with income (Binswanger, 1980). It follows that wealthier farmers, who show less risk aversion, would favour contracts. If, on the other hand, the contract entails credit provision, then small, risk-averse farmers would also prefer to sign a contract with a processing company. Likewise, due to lower shadow price for household labour, a contract could be appealing for a smallholder who can use household labour in production. Yet, if there were other risk-reducing options in the form of non-farm earning opportunities, in spite of their risk aversion, some farmers would decide against contract farming. Assuming that the wage employment is less risky than contract farming, highly risk-averse credit-constrained farmers are expected to choose employment with processing companies.

The implications of the theory are that the spread of gains from farming differ by vertical coordination choice. The benefits of any specific coordination alternative for participants depend on the contract terms and participants' characteristics. The gains from vertical

coordination are assumed to be greater for estate and contract farmers than for non-integrated farms. Furthermore, the decision about estate or contract farming has consequences for the whole sector and broader rural environment. If processing companies choose to work closely with wealthier farmers, poorer producers will fail to benefit directly from different vertical coordination alternatives. Thus, vertical coordination has the potential to affect the way wealth is distributed within the sector, and can impair existing economic patterns (Key and Runsten, 1999).

3. Descriptive Analysis

3.1. Farm Characteristics

Table A1 shows that processing companies tend to organise production on larger farms and to hire more full-time workers as this reduces operational costs. Estate farms are on average twice as large as contract or non-integrated farms that set just under 2ha of production surface for catfish farming. Processing companies tend to own land on which they produce catfish; land is rented on only around 35 per cent of estate farms. To start the primary production, processing companies can acquire land use rights from existing farmers or purchase and convert new land[6]. After the land is acquired, processors hire production managers or technicians to manage catfish production according to their precise specifications. Rarely are traditional farmers employed with the intent to manage production for a processing company[7]. This reflects the need of the sector for a workforce endowed with specialised skills or a preference for quickly learning new skills. Table A1 shows that estate farmers have fewer years of experience with catfish farming than contract or independent farmers, but they have higher rate of secondary school completion. The motives for becoming an estate farm employee are primarily monetary, but some have arrived at this position through a combination of factors such as tradition, occupational preference or recommendations from friends or relatives. For 51 per cent of the employees, working on an estate farm is a way of earning higher income, for 22 per cent of them it is the preferred occupation, for 13 per cent of them it is related to their

[6] In Vietnam, land is owned by the state, but land titles can be legally transferred, mortgaged or inherited (Ravallion & van de Walle, 2008).

[7] In this case, a farm is sold to a processing company and that the farmer becomes an employee.

previous work experience and for eight per cent, it is an occupation related to their field of studies. Albeit a part of 'a rapidly emerging class of landless wage labour' (Akram-Lodhi, 2004, p. 757), the higher education level of estate farm employees enables them to find employment on estate farms and potentially raise their living standards and wealth. Work force on estate farms is the youngest, comprising farmers who come from smaller households with fewer children.

The employees on the estate farms form a part of the landless labour force that has either 'lost their land either due to government repossession or a household economic situation' (Akram-Lodhi, Borras, & Kay, 2007, p. 182) or that works on estate farms until establishing their own farms. Estate farms receive all the inputs and equipment required for production from the processing company. The average village-level price for catfish is the highest for estate farms and the lowest in case of non-integrated farmers. In terms of distance to the nearest health centre, estate farms have an advantage over both non-integrated and contract farms.

Contract farmers have on average less household members engaged in catfish farming, but they participate by 40 per cent more often in community meetings than other farm categories. Secondary education is more common among contract farmers than among non-integrated farmers. Contract farmers are least likely to rent land for catfish production and they have on average four years of experience with catfish more than estate farm employees.

Key motives for entering into contract farming appears to be price stability, as 46 per cent of contract farmers identified stable price as one of the reasons for contracting. Only 18 per cent stated that they expect to obtain higher price through contract. Secondary motives include credit access and more insurance, which were relevant for 36 per cent and 31 per cent of the contract farmers, respectively. Taken together, these reasons for contracting illustrate high instability and competitiveness in the catfish sector. They also illustrate that processors are powerful actors in the sector as they are able to dictate the terms in the market.

The contract arrangements are not exempt from hold-up problems, which arise when the return from the alternative trading arrangement for the farmer is lower than the return from contract. In the catfish sector, processing companies could use quality inspections performed before the purchase, to exacerbate these problems. The quality testing includes analysis of the presence of banned antibiotic residues, inspection of flesh colour and measurement of fish size. Processing companies have been reported to delay the delivery of quality inspection results while waiting for farmgate prices to decrease in the periods of lower demand. In this way, farmers bear huge costs of prolonged feeding, whereas processing companies can coerce them into accepting low prices or unfavourable terms such as staggered or delayed payments (Belton, Little, & Sinh, 2011). Even though they were put in place to preclude information asymmetry problems, quality inspections could be used to unfairly increase profits for processing companies.

In periods of high demand, processing companies are at risk of default by farmers. Contract clauses are in principle designed to prevent farmers from 'side-selling' when the market price surpasses the contract price, but the experience has shown that farmers can default without serious consequences by selling output to other processors or middlemen who offer higher prices.

Spot market transactions are still present in the catfish sector, as the high number of non-integrated farmers in our sample illustrates. In our sample, 75 per cent of farms sell directly to processing companies while the remaining 25 per cent sell to middlemen. The main reason for selling through the middlemen is better accessibility, while the main motives for selling directly to a processing company are guaranteed sales and guaranteed price, followed by access to technical assistance, inputs and credit. The existence of spot market tells that it is possible to participate in a modern export sector without formal arrangements with processing companies. It is possible that this category of farmers is not experiencing adverse effects of the processors' selection process, but that producing independently could have some advantages. Indeed, 61 per cent of these farmers think they are doing better without the contract.

With an average of 10 years of farming catfish, non-integrated farmers are the most experienced. Their farms are, however, located furthest away from the buyers' facilities compared to both estate and contract farms. Non-integrated farmers are more frequently religious than contract and estate farmers.

Table A1. Differences in farm characteristics for different vertical coordination options

Variables	Unit	Whole sample	Non-integrated farmers	Estate farmers	Contract farmers
Aquaculture area size in 2010	Hectare	2.63	1.79	4.51***	1.81
		(4.95)	(3.67)	(5.88)	(4.86)
Household size	Persons	3.74	3.98	3.14***	4.04
		(1.59)	(1.38)	(1.56)	(1.70)
Age of the household head	Years	42.38	45.08	36.44***	44.92
		(12.49)	(12.87)	(11.23)	(11.29)
Having secondary education (1/0)	Per cent	35.14	22.33	43.52***	42.05***
		(47.83)	(41.85)	(49.87)	(49.65)
Share of children 15 and under	Per cent	0.35	18.61	11.26***	20.73
		(0.46)	(0.21)	(0.18)	(0.22)
Household labour	Persons	2.11	2.32	2.04	1.93**
		(1.96)	(1.35)	(3.03)	(1.01)
Asset index	Index	0.01	0.07	-0.14	0.08
		(0.10)	(1.07)	(1.13)	(0.73)
Experience with catfish	Years	8.31	10.61	4.87***	8.98*
		(6.59)	(8.03)	(3.14)	(5.82)
Participation in community meetings	Frequency	2.64	2.29	2.38	3.29**
		(3.32)	(2.81)	(3.93)	(3.15)
Religious (1/0)	Per cent	66.67	77.67	56.47***	63.63**
		(47.23)	(41.85)	(49.87)	(48.38)
Renting land (1/0)	Per cent	19.20	14.56	36.47***	7.95*
		(39.46)	(35.45)	(48.42)	(27.21)
Distance to buyer	Kilometres	24.58	31.66	19.50***	21.21**
		(32.06)	(38.87)	(22.87)	(29.61)
Distance to nearest health centre	Kilometres	16.23	19.53	10.81*	17.59
		(38.72)	(44.58)	(29.29)	(39.21)
Average village-level price	VND/kg	12,404	10,696	13,951***	12,909**
		(7,946)	(7,874)	(7,229)	(8,390)
Monthly household expenditure	VND million	17.73	13.38	15.92	24.65*
		(51.25)	(1.73)	(2.99)	(9.09)
Monthly per capita expenditure	VND million	6.46	4.79	7.52**	7.42
		(14.31)	(0.63)	(1.31)	(2.29)
Number		276	103	85	88

Notes: Non-integrated farms are the farms that sell on the spot market, estate farms are processor-owned farms that are operated by hired labour and contract farmers are households producing catfish on contract with the processing companies. There is no overlap between categories: one household can belong to only one category. Significance levels: * p<0.10, ** p<0.05, *** p<0.01. Standard deviation is in parentheses. Expenditure values are expressed in Vietnamese Dong (VND) million. 1 USD ≈ 20,500 VND. Per capita expenditure level is calculated using OECD adult equivalence scales.

The observed farm categories do not defer significantly in terms of the asset index that comprises both production and household assets. This could imply that the rate of success of catfish farmers is potentially determined by the capability to better manage variable costs that arise in production.

3.2. Poverty and Welfare

Table A1 shows that non-integrated farms have the lowest expenditure level, but the difference in per capita expenditure is significantly lower only when compared to estate farms. From the cumulative distribution of consumption expenditure shown in Figure 1, we see that the expenditure level is similar across the observed farm categories. Even though contract and estate farms have 65 per cent higher expenditure levels than non-integrated farms when evaluated at the mean, high unconditional distributional differences are not observable. The Kolmogorov-Smirnov test does not show evidence of statistically significant differences between expenditure distributions for the three observed farm categories (test value 0.148 with p=0.208 for a comparison of non-integrated and estate farms and 0.149 with p=0.197 for a comparison of non-integrated and contract farms). The conditional differences are, however, possible. For example, the difference between expenditure distributions becomes more apparent after comparing only younger farmers (Figure 1).

Poverty is not common among the surveyed farms. The share of households below poverty line was calculated using the 1.25 USD and 2 USD/day poverty lines for extreme and moderate poverty. These poverty lines were converted to local currency equivalents using purchasing power parity (PPP) exchange rates. The PPP exchange rate of 1 USD to 4,713 VND in 2005 (IBRD, 2008) was updated to 2010 rates using the consumer price index (GSO, 2012). In the sample, nine per cent of households have consumption level lower than the 1.25 USD/day poverty line and 22 per cent of households have per capita consumption lower than 2 USD/day poverty line. Figure 2 shows that the share of extremely and moderately poor households is highest among non-integrated catfish farms. Estate farms and contract farms have almost identical share of poor households.

However, in terms of the Vietnamese national poverty line for rural areas, which amounts to 360,000 VND per person per month (GSO, 2011), only 3 households from the sample can be classified as poor.

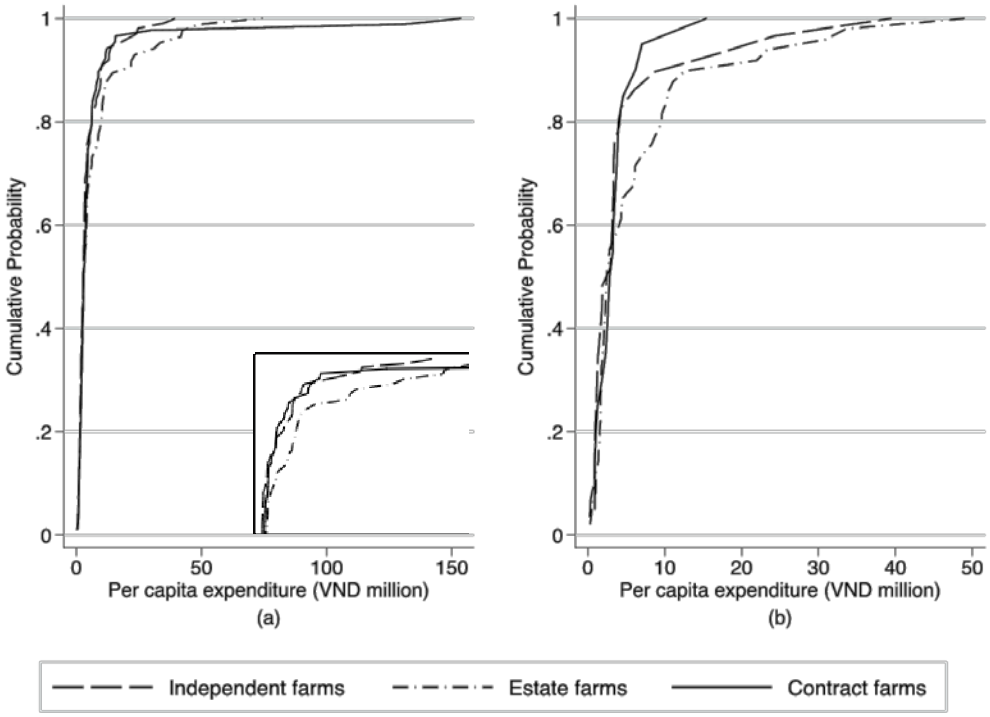

Figure 1. Cumulative distribution of per capita consumption expenditure by farm type
Notes: Panel (a) shows the cumulative distribution of per capita consumption expenditure for all farms and Panel (b) shows the distribution for farmers younger than 38.

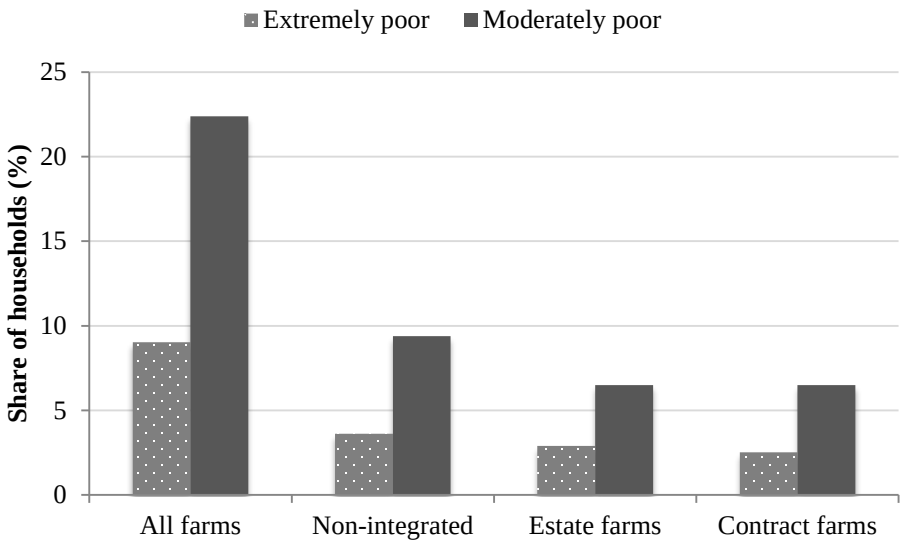

Figure 2. Share of poor households in different farm categories